Course guide
200004 - CD - Differential Calculus

Last modified: 11/06/2023

Unit in charge: School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 7.5 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: ANDRES MARCOS ENCINAS BACHILLER

Others: Segon quadrimestre:
ANGELES CARMONA MEJIAS - M-A, M-B
ANDRES MARCOS ENCINAS BACHILLER - M-A, M-B
M. JOSÉ JIMÉNEZ JIMÉNEZ - M-A, M-B

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
2. CE-3. Have the knowledge of specific programming languages and software.
3. CE-4. Have the ability to use computational tools as an aid to mathematical processes.

Generical:
4. CB-1. Demonstrate knowledge and understanding in Mathematics that is founded upon and extends that typically associated with Bachelor's level, and that provides a basis for originality in developing and applying ideas, often within a research context.
5. CB-2. Know how to apply their mathematical knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader or multidisciplinary contexts related to Mathematics.
6. CB-3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements.
7. CG-1. Show knowledge and proficiency in the use of mathematical language.
8. CG-2. Construct rigorous proofs of some classical theorems in a variety of fields of Mathematics.
9. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
10. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
11. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

TEACHING METHODOLOGY

(Section not available)

LEARNING OBJECTIVES OF THE SUBJECT

(Section not available)

STUDY LOAD

Type	Hours	Percentage
Hours small group	30,0	16.00
Guided activities	7,5	4.00
Self study	105,0	56.00
Hours large group	45,0	24.00

Total learning time: 187.5 h

CONTENTS

1.Topology of Rn. Sequences of vectors.

Description:
- Euclidean, normed and metric spaces. Case study: Rn.
- Open and closed sets. Interior, exterior and boundary of a set.
- Sequences in Rn. Limit. Cauchy sequences and completeness. Characterization of closed sets by sequences.
- Bounded sets. Compactness. Equivalent definitions. Case study: R^n. Bolzano-Weierstrass theorem.
- Connected sets.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 4h
Self study : 15h

2.Limits and continuity of functions.

Description:
- Functions of several variables. Level sets and graphics of real functions
- Limit of a function at a point (special emphasis on the case of two variables).
- Continuity at a point and a set. Properties of continuous functions.
- Continuity and compactness. Weierstrass theorem.
- Uniform continuity. Heine-Cantor theorem.
- Equivalence norms and equivalence metrics. Fixed point theorem.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 4h
Self study : 15h

3.Differentiability.

Description:
- Differentiability at a point. Hyperplane tangent to the graph of a real function.
- Partial and directional derivatives. Jacobian matrix. Gradient of a function.
- Differentiability and operations. Chain rule. relationship between diferenciability, continuity and partial derivatives.
- Differentiability in an open set. Mean Value Theorem. Functions of class C ^ 1.
- Differentiable curves. Tangent vector.

Full-or-part-time: 34h
Theory classes: 8h
Practical classes: 6h
Self study : 20h

4. Theorems of differentiable functions.

Description:
- Higher-order partial derivatives. Schwarz theorem. Cn-class functions. Examples of mathematical physics equations. Change of variables in equations containing paertial derivatives.
- The inverse function theorem. Diffeomorphisms.
- The implicit function theorem. Derivatives of implicit functions.
- Rank theorems.

Full-or-part-time: 41h
Theory classes: 10h
Practical classes: 6h
Self study : 25h

5. Taylor formula. Local extrema.

Description:
- Taylor formula. Expressions of the rest.
- Local extrema. Critical points.
- Clasification of critical points: quadratic forms, Hessian matrix.
- Criteria of Silvester and of eigenvalues of the Hessian matrix.

Full-or-part-time: 33h
Theory classes: 8h
Practical classes: 5h
Self study : 20h

6. Submanifolds of Rn and constrained extrema.

Description:
- Submanifolds of Rn. Tangent vectors. Tangent and normal spaces at a point.
- Parameterized and implicit submanifolds. Regular curves and surfaces.
- Constrained extrema and Lagrange multipliers.
- Absolute extrema.

Full-or-part-time: 32h
Theory classes: 7h
Practical classes: 5h
Self study : 20h

GRADING SYSTEM

Final Mark= Max(Final Exam, 0,7*Final Exam+0,3*Midterm Exam)
Eventually, the grading of the mid-term exam could be modified by other grades.

An extra exam will take place on July for students that failed during the regular semester.

BIBLIOGRAPHY

Basic:
- Carmona, Ángeles; Encinas, Andrés M.; Jiménez, M. José. Càlcul Diferencial (Apunts de l'assignatura).
- Marsden, Jerrold E.; Hoffman, Michael J. Elementary classical analysis. 2nd ed. New York: Freeman and Co, 1993. ISBN 0716721058.
- Mazón Ruiz, José M. Cálculo diferencial : teoría y problemas. Valencia: Universidad de Valencia, 2008. ISBN 9788437071886.
- Chamizo, F. Cálculo III (notes d'un curs a la Universidad Autónoma de Madrid) [on line]. [Consultation: 26/06/2023]. Available on: http://www.uam.es/personal_pdi/ciencias/fchamizo/asignaturas/to2009/calculoIII0002/calculoIII0002.html.

Complementary:
- Bombal Gordon, Fernando ; Marín, R. ; Vera. Problemas de análisis matemático. 2 ed. Madrid, 1988. ISBN 8472881008.